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Ministry of
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SINGLE SURFACE TREATMENT WITH STYRELF 103 BINDER CONSTRUCTION REPORT

MATERIALS INFORMATION

ENGINEERING MATERIALS OFFICE

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS
ONTARIO

SINGLE SURFACE TREATMENT WITH STYRELF 103 BINDER
CONSTRUCTION REPORT

by

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Elastic Properties of Styrelf 103 Binder

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1. INTRODUCTION

On 85 07 22 a single surface treatment was placed over hot mix pavement on Hwy. 2, West of Prescott. The surface treatment differed from the normal surface treatments because a special asphalt binder, Styrelf 103[1], was used. Styrelf 103 is a bituminous binder produced by bonding a polymer onto an asphalt cement by chemical reaction. The manufacturer claims that the improved binder results in more durable surface treatments.

The surface treatment was placed to extend the hot mix pavement life. The existing pavement, placed in 1977, was deteriorating faster than expected due to popouts and ravelling. The project was initiated and administered by R.C. Wycliffe, District Engineer, Kingston and his staff. Bakelite Thermosets Ltd. of Montreal was the contractor as well as the manufacturer of the Styrelf. Sebeq carried out the work under the direction of J. Turcotte, of Bakelite.

2. EXISTING HOT MIX PAVEMENT

Hwy. 2 was paved in 1977 by McFarland Construction Ltd. under Contract 76-100. Sections of Contract 76-100 were new construction and sections were resurfacing. Paving over new construction consisted of one lift of HL-2, two binder courses of HL-4 and a surface course of HL-4. Resurfacing consisted of one HL-4 binder and an HL-4 surface course. The surface course mix was supplied from McFarland's portable plant set up in Joyceville.

At the time of surface treatment, the HL-4 pavement exhibited a uniform loss of coarse aggregate, "popouts", of approximately 10%. There were about 30 sections 8 m by 3 m wide, spaced at regular intervals, that were ravelled. A few of the ravelled sections had small areas 13 x 15 cm where the surface course had been lost down to the binder. None of these areas were patched before surface treating.

There was a continuous crack along centreline that had just been routed and sealed with hot poured material. There were three or four sections with slight alligator cracking in the wheel tracks. Generally, the pavemernt cross section was good, with slight wheel track rutting in some

1. **Registered trademark.**

some locations. The pavement ride was good. The 1984 AADT traffic was 4100 in the two lane section that was treated.

The traffic type was urban communter traffic travelling to and from a large industrial plant. There was an estimated 10% commercial vehicles. The turning movements are limited to one main intersection. The speed limit was 80 km/h.

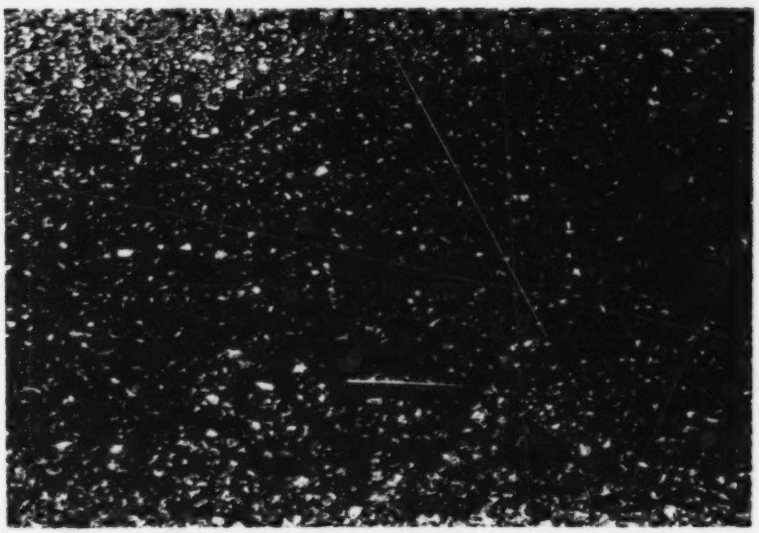

Figure 1: Uniform loss of coarse aggregate in existing HL-4 pavement

Figure 2: Typical ravelled section in existing HL-4 pavement

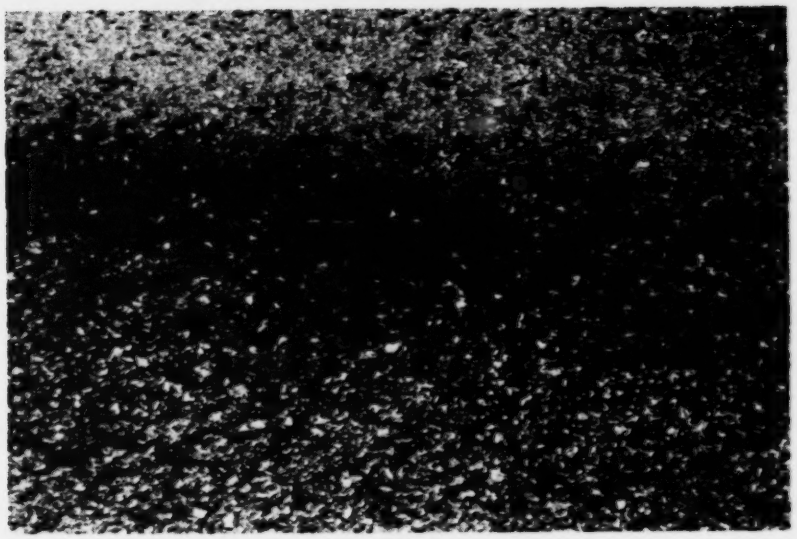

Figure 3: Loss of surface course of existing HL-4 pavement

3. MATERIALS

3.1 Aggregate

The aggregate for the project was selected by Bakelite from Beaver Asphalt in the City of Gloucester. The limestone aggregate was a single size washed aggregate passing the 16.0 mm screen with 96% retained on the 9.5 mm screen. See the appendix for aggregate gradings and physical characteristics. The aggregate was stockpiled on the job site.

3.2 Binder

The binder, Styrelf 103, was manufactured in Montreal and transported to the jobsite in an insulated tanker at approximately 165°C. The viscosity of the binder is adjusted at the Montreal plant by the addition of a petroleum distillate. The light fraction of the distillate evaporates during the first few weeks after spraying leaving the final characteristics of the binder. The result is a binder comparable with 85/100 penetration asphalt cement, but with excellent low and high temperature elasticity characteristics. The Ministry does not have specification requirements or tests for Styrelf 103. Typical characteristics of the residual styrelf 103 binder after aging can be found in the appendix.

3.3 Wetting Agent

A wetting agent, to cut waterfilm on the aggregate, called "dope", is sprayed over the binder, before applying the aggregate. The "dope" ensures a good bond between the aggregate and the binder. Different types of aggregate require different wetting agents.

4. APPLICATION RATES

The application rates for aggregate and binder were selected by Bakelite from their design procedure. The design application rate for aggregate was 25 kg/m^2 ± and for binder was 1.40-1.50 kg/m^2, depending on the existing pavement condition. The "dope" was to be applied at 5 g/m^2.

The actual average application rates on the job were 1.54 kg/m^2 for the binder and 23.7 kg/m^2 for the aggregate.

5. EQUIPMENT

The following equipment was used on the job:

a) Distributor, Rincheval, manufactured in France.
The distributor is a hydrostatic type, fully automatic, computer controlled with a digital readout panel showing binder temperature in degrees Celcius, speed in km/h, distribution rate in kg/m^2 and pump speed in RPM. The spray bar can be moved laterally and up and down by controls on the panel. Spray nozzles can be added or disconnected two at a time in the main bar and one at a time in the extensions without altering the application rate. The distribution rate can be maintained to ± 1% accuracy. The distributor is equipped with a heater which heats transfer oil so that the binder is not in direct contact with the flame. The spray bar is jacketed with hot oil; the standard distributor spray bar is heated by circulating the binder. A second spray bar to apply "dope" is mounted behind the main spray bar.

b) Pneumatic-tired roller, Tampo, 8 tonne.
This is the standard roller used in surface treatment work.

c) Tandem, steel-tired roller, Galion.
The Galion roller had a 25 mm thick rubber pad vulcanized to each drum. This roller was not ballasted.

d) Aggregate Spreader, Koehring.
This model is the standard spreader used in surface treatment work.

e) 3 - Tandem dump trucks.

f) 1 - Power Broom, towed type.

g) 1- Front end loader, Clarke 558.

h) 1 - Pick-up truck.
The MTC pick-up truck was equipped with a sign and used to convoy traffic.

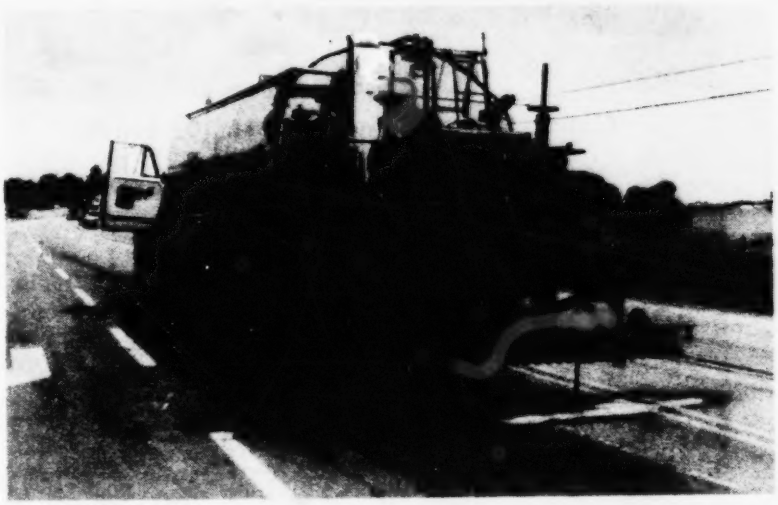

Figure 4: Rincheval Distributor equipped to spray 165°C Styrelf 103 binder

6. CONSTRUCTION

The work commenced at 12:30 on 85 07 22. The planned starting time was 8:00 a.m. but was delayed because the Styrelf in the distributor had to be heated and there was a minor problem with the aggregate spreader. Application commenced at the west end of the job and proceeded easterly. When approximately 1 km was completed, the adjacent lane was surface treated. This sequence of work was followed for the entire project.

The binder and "dope" were applied by the distributor. Next, the aggregate was applied so that the distance between the distributor and the aggregate spreader was not more than 30 m. A minimum of two passes were made with the pneumatic-tired roller which was operated at approximately 6 km/h. The tandem roller completed the rolling with two passes at approximately 4 km/h. The rollers were operated within 300 m of the aggregate spreader.

Figure 5: Spraying Styrelf 103 binder

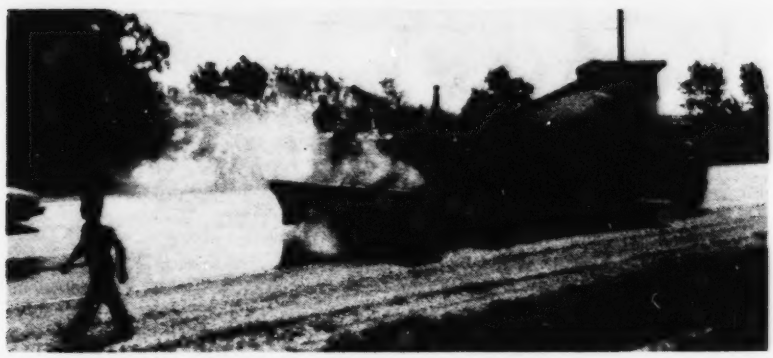

Figure 6: Applying the aggregate

Figure 7: Rolling

The distributor would stop spraying each time the aggregate spreader stopped to hook up a new truck. The time required to spray a distributor load of binder varied from half hour to one hour. Distributor filling time was about one half hour.

The contractor checked the binder application rate by placing two foam pads on the road and spraying over them. The pads were later taken to the laboratory and weighed. The application rates obtained were 1.49 and 1.62 kg/m^2. The aggregate application rate during construction appeared excessive. The contractor said that the heavy application rate was necessary to prevent the construction equipment tires from touching the binder. Occasionally the binder and aggregate was picked up and the tires had to be cleaned.

Sweeping of the work commenced at 18:00 and was completed at 19:30 except for entrances and driveways which were swept the next morning.

Traffic control was supplied by the Ministry. Flagmen were posted at each end of the site, about 2.9 km apart. Traffic was stopped by the flagman and then was convoyed at 20 km/h with the MTC pick up truck past the equipment to the next flagman. The pilot vehicle turned around and convoyed the waiting cars in a similar manner. The pilot vehicle convoyed traffic until 19:30 when the sweeping was completed.

Figure 8: Styrelf single surface treatment one month after construction

7. COSTS

The single surface treatment cost was $2.10 per m^2 including materials, equipment and construction but excluding traffic control.

Using the price of $2.10 per m^2, the cost to place a single surface treatment with Styrelf 103 binder was $15,330 per km (7.3 m wide).

8. SOUND LEVELS

Sound level measurements were conducted to compare the sound levels of the single surface treatment and the existing HL 4 pavement. The sound measuring systems were located 15 m north of the centreline of the westbound lane adjacent to the single surface treatment and the HL 4 pavement.

The single surface treatment generated sound levels 3 to 5 dB higher than the existing HL 4 pavement in the frequency range less than 1000 Hz. In the higher frequency range, greater than 2000 Hz, the existing HL 4 pavement generated sound levels 2 to 4 dB higher than the single surface treatment. The low frequency sound levels from the single surface treatment are louder than the high frequencies generated by the existing HL 4 pavement and are thus more annoying.

In terms of the overall sound level (Leq, dBA) measurements, with a traffic mix of 10 to 15% medium or heavy trucks, the single surface treatment generated sound levels approximately 2 decibels greater than the existing HL 4 pavement. The memorandum from Mr. C. Blaney of the Research and Development Branch can be found in the appendix.

9. OBSERVATIONS

1. The surface treatment work was successfully completed.
2. Rolling was adequate but more effective compaction could be obtained by replacing the tandem roller with a vibratory surface treatment roller.

3. The contractor's average production rate was 0.5 km/h.
4. The binder was sufficiently set in 1-1/2 hours to permit traffic at 80 km/h.
5. The binder thickness was 2-3 mm or approximately 20% of the aggregate thickness.
6. There was the occasional loose stone on the roadway after sweeping when traffic was resumed.
7. The single surface treatment generated sound levels approximately 2 decibels greater (leq, dBA) than the existing HL 4 pavement with a traffic mix of 10 to 15% medium or heavy trucks.

10. RECOMMENDATIONS

1) The flow of salt brine across the lanes should be monitored this winter and the surface treated section should be compared to the adjacent hot mix pavement in drifting and blowing snow conditions.
2) The carbide snow plough blades should be closely monitored to prevent damage from the surface treatment.
3) A vibratory surface treatment roller should be used with the pneumatic-tired roller in future work.
4) The surface treatment should be evaluated in the spring of 1986.

11 APPENDIX

TABLE 1: AGGREGATE GRADING

MTC SIEVE mm	Percentage Retained
16.0	1.0
13.2	26.9
9.5	96.4
6.7	99.0
4.75	99.5

TABLE 2: AGGREGATE PHYSICAL CHARACTERISTICS

Test	Sample No. 8128
Petrographic No. Max.	101.5
Magnesium Sulphate, 5 Cycles, Loss, %	3
Absorption, Max, %	0.85
Flat and Elongated Particles, Max, %	9
Loose Unit Mass, t/m^3	1.378
Wash Pass 75 um, %	0.2
Aggregate Abrasion Value[1]	7.72
Polished Stone Value [2]	47.0

NOTES: 1. Britsh Standard BS 812, 1975
The resistance of aggregate particles to wear is measured by the AAV test. A low value indicates a high resistance to wear. A typical limestone has a AAV range of 8-15.

2. Britsh Standard BS 812, 1975
An aggregate with a high PSV may be thought of as having good resistance to the action of polishing by vehicle tires. A high value indicates a better aggregate. A typical limestone has a PSV range of 40-50.

TABLE 3:

CHARACTERISTICS OF RESIDUAL STYRELF 103 BINDER AFTER AGING FOR 15 DAYS AT 50° C IN THIN LAYER[1]

Penetration at 25°C	(ASTM D 5/73)	1/10 mm	83
R and B softening point	(ASTM D 36/76)	(°C)	57
Fraass Breaking Point	(IP 50/53)	(°C)	-20

		20°C 500 mm/min	- 10° C 10 mm/min
Tensile Strength:			
. at flow threshold	10^5 Pa	2.3	10
. break strength	10^5 Pa	1.2	4
. elongation at flow threshold	(%)	25	25
. elongation at break	(%)	800	400

1. Taken from the Styrelf 103, 1980 edition.

memorandum

Ontario

To: Mr. Soren Pedersen
Acting Head,
Design Development Section
Highway Design Office
Downsview

Date: 85 11 20

Subject:Noise Level Emissions from Surface Treated Asphalt Pavement (Styrelf), near Prescott.

This memorandum is written in response to your request dated September 20, 1985 as a result of concerns raised by Mr. Gord Bell, Senior Environmental Planner, Eastern Region. Mr. Bell recieved noise complaints resulting from the overlay of seven year old HL-4 asphalt pavement with a surface treated asphalt (Styrelf).

Measurement Procedure

Sound level measurements were conducted at the north side of Highway 2, between Maitland and Prescott. The sound level measuring systems were located 15 m north of the centreline of the westbound lane, one system adjacent to the HL 4 and the other adjacent to the Styrelf. Sound level measurements of the road traffic noise measured at these two locations were done simultaneously by recording sound levels on magnetic tape for later analysis in our Laboratory.

Several different sets of sound level measurements were conducted by recording sound levels emitted by the total (normal) traffic flow passing by on the two adjacent pavement sections. Analysis of the data was done in two ways. Firstly, by calculating the average total normal traffic flow noise (measured over a one hour period). Secondly, by analysing (using a spectral analyser) the frequency component of the road traffic. Since both measurement locations were identical in terms of distance and traffic flow, any differences in the measured sound levels can be attributed to the pavement/tire noise.

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Equipment used to conduct measurements:

Bruel & Kjaer Calibrator, Type 4230
Bruel & Kjaer Integrating Sound Level Meter, Type 2218
Bruel & Kjaer Noise Level Analyser, Type 4426
Bruel & Kjaer Alphanumeric Printer, Type 2312
Bruel & Kjaer Digital Frequency Analyser, Type 2131
Uher 4200 Stereo Report Monitor Tape Recorder
BASF Recording Tape, Type DP 26

Discussion

An analysis of the full octave band frequency spectra of sound levels emitted by the traffic passing on the pavements are compared on the figure entitled, Full Octave Sound Levels. In addition to the overall difference in decibel levels, the two pavements have also different frequency spectra. The Styrelf sound levels are about 3 to 5 dB higher in the frequencies less than 1000 Hz than are the corresponding sound levels obtained for the HL-4 pavement. At higher frequencies (greater than 2000 Hz) the sound levels of the HL-4 pavement are higher by about 2 to 4 dB.

The traffic mix measured for comparison purposes of the two pavements frequency spectra contained several heavy trucks which because of their significant low frequency noise emissions tend to mask the differencies in the pavement/tire noise levels. We would expect the differences between the pavements to be greater if there were higher volumes of passenger cars.

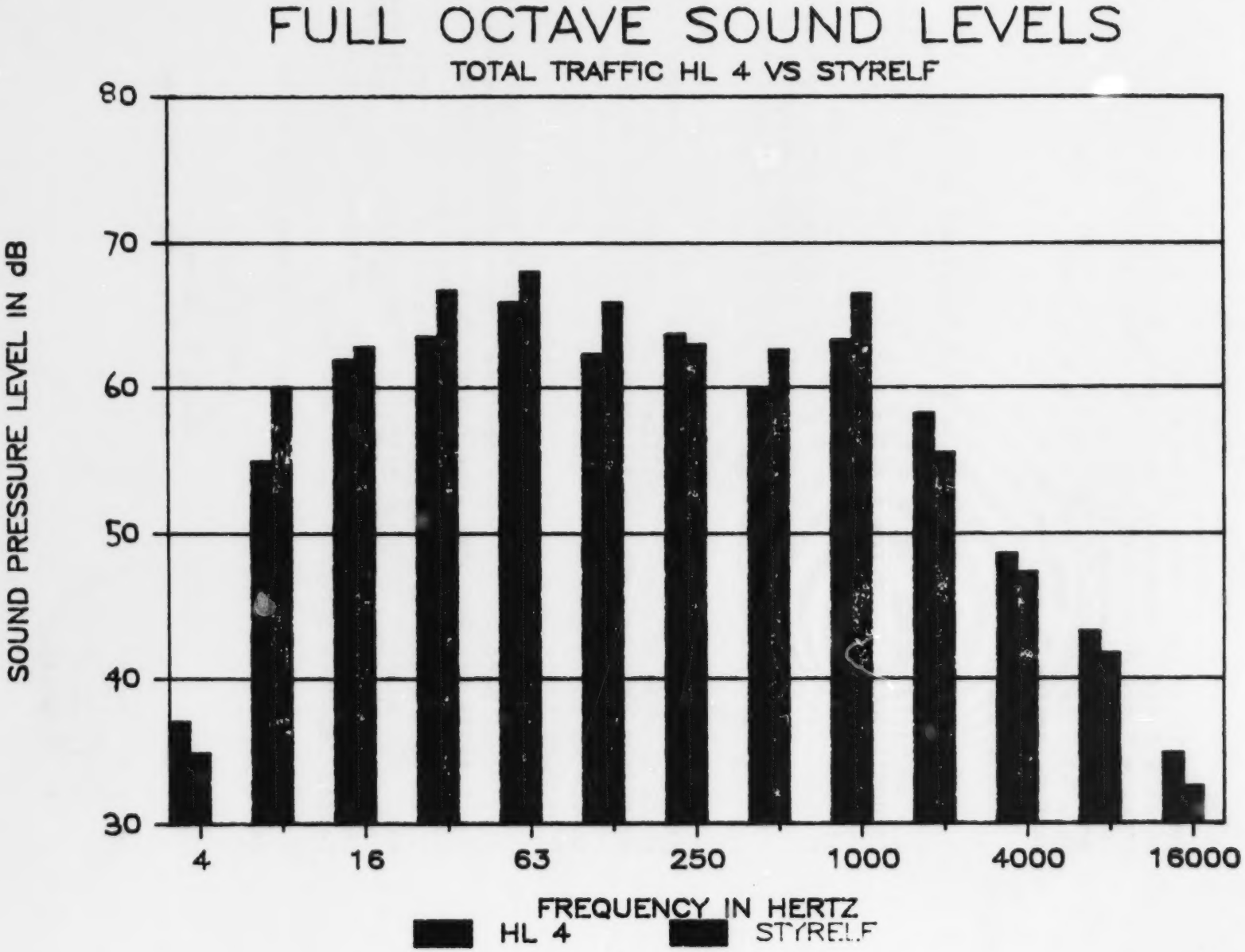
In terms of overall sound level (Leq, dBA) measurements, the difference between the pavements was approximately 2 decibels. The traffix mix for this test had about 10 to 15 % medium or heavy trucks. This measured difference would be higher if there were a greater percentage of automobiles in the traffic mix. The asphalt pavement with which the Styrelf pavement was compared was not in perfect condition. The difference between the Styrelf and a new HL pavement would be higher than the levels reported for this comparison test.

If you have any questions or concerns please call me at 248-3355.

Chris T. Blaney

Chris T. Blaney
Project Research Technician

cc. F.W. Jung
G. Bell
D. Lynch ✓
P. Korgemagi


FULL OCTAVE SOUND LEVELS
TOTAL TRAFFIC HL 4 VS STYRELF
SOUND PRESSURE LEVEL IN dB
80
70
60
50
40
30
4
16
63
250
1000
4000
16000
FREQUENCY IN HERTZ
HL 4
STYRELF